Toward the integration of different sensors in the operating room using medical image registration techniques

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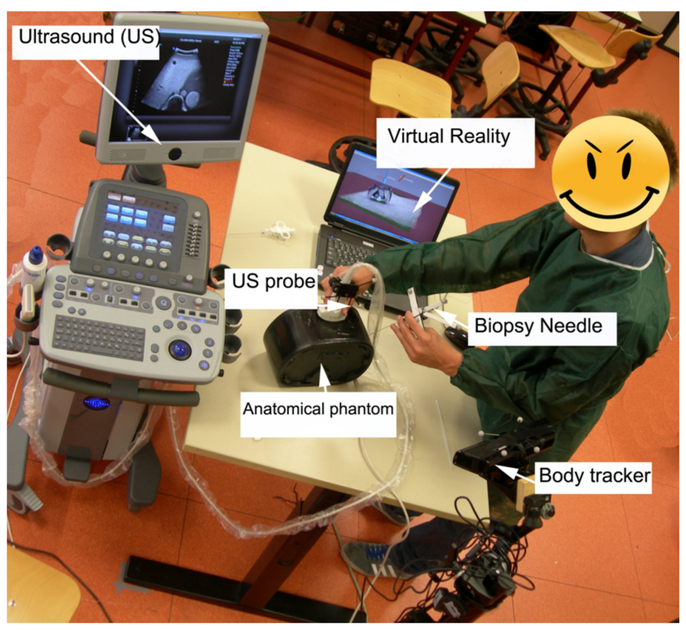
Objectives and Motivation

-implementation of a navigation system for minimally invasive surgery (MIS) or for needle guidance [4].

-MIS is a procedure that involves the use of laparoscopic devices and remote-control manipulation of instruments with indirect observation of the surgical field

-both MIS and needle insertion procedures make intense use of images, since the physician has no open access to the internal anatomy

-advance navigation system could increase the safety of the procedure and could spread the application cases.



-by using medical image registration we can integrate informations from different surces

Currently available systems

[3] open liver assisted surgery

-landmark acquisition

-rigid registration

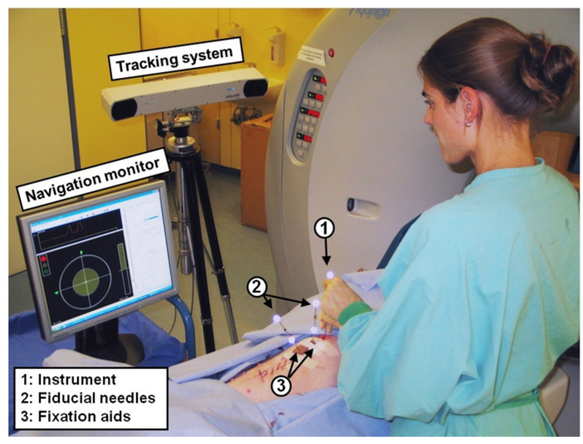
-optical tracking

[2] abdominal procedures

–initial rigid registration

-intra-operative deformations compensated by mathematical models

-deformation field generated by a surface Laplacian equation



[1] percutaneous abdominal Intervention

-optical tracking

-breathing compensation

-fiducial insertion (invasive)

-rigid registration

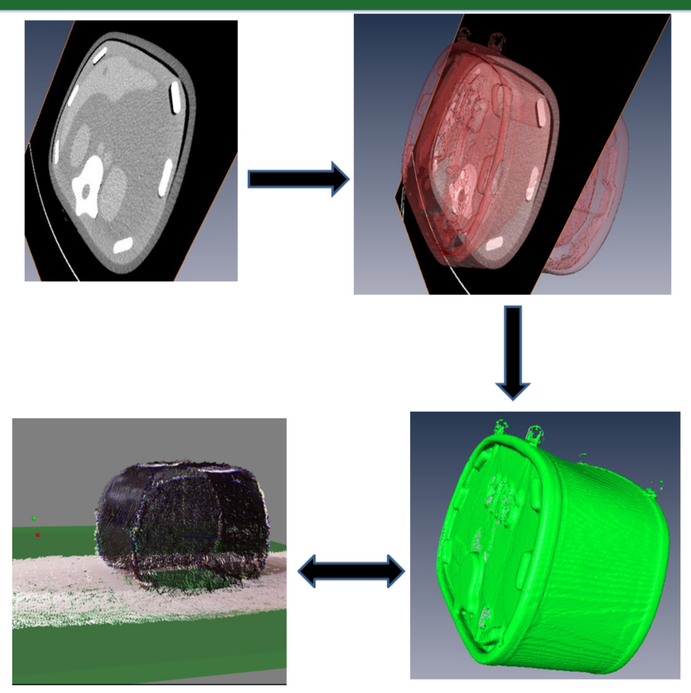
Method

Pre-operative phase:

•CT (MRI) image acquisition
-image processing (segmentation, filtering)
-3D organ reconstruction, model extraction
-landmark identification
-target identification

•RGBD image acquisition (body surface+ texture)

•Initial registration: landmark based and surface based, rigid or afine to handle sharing and/or some scaling



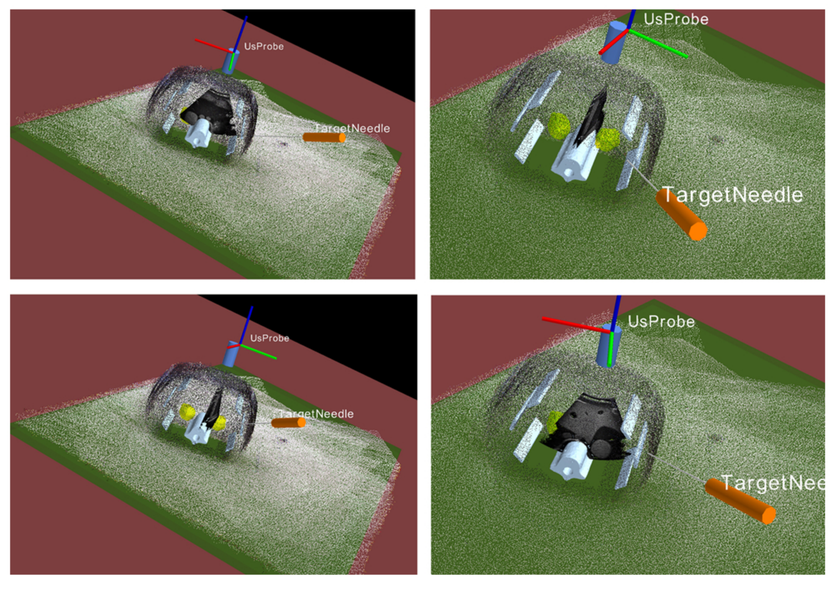
Intra-operative phase

•Ultrasound (US) 2D image acquisition with optical tracked probe =>
-3D US image reconstruction (Stradwin SW)
-landmark identification
-organ segmentation

• tracked RGBD surface acquisition
-landmark identification

•Intra-operative registration
-landmark based (initial)
-intensity based
-rigid (initial)
-non-rigid

Navigation



Discussion

•new navigation system that uses more sources of information

•new type of images will be generated and integrated

•extraction and identification of features for the rigid and non-rigid correspondences

•tracking of the body (organ) position and orientation + computation of the deformation => mapping of the surgical instruments in the real scenario

•use of phantom model for validation

•Future works: in-vivo, ex-vivo tests, new non-rigid registration algorithms implementation

References

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[2] '*Model-updated image-guided liver surgery: Preliminary results using surface characterization*', P.Dumpuri et al., in Progress in *Biophysics and Molecular Biology*, 2010

[3] '*A navigation system for open liver surgery: design, workflow and first Clinical applications*', M.Peterhans et al., in *International Journal of Medical Robotics*, 2010

[4] '*Multimodal 3D Data Fusion and Reconstruction for Needle Insertion Guidance in Cryoablation Procedures*' B. Maris et al., *IROS 2011*, San Francisco, California

[5] '*Multimodal data fusion and registration for needle guidance in percutaneous procedures*' B. Maris, D. Dall'Alba, P. Fiorini, *CARS 2012*, June 27–30 (to be presented)

[6] '*Marker based accuracy analysis of RGB-D sensor for image guided applications*' D. Dall'Alba, B. Maris, C. Reghelin, P. Fiorini, *CARS 2012*, June 27–30 (to be presented)